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Abstract title: Design and performance evaluation of a high stability ka-band water vapor radiometer

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Abstract:

The design of two new high stability microwave water vapor radiometers is presented along with a performance evaluation. The radiometers operate next to a spacecraft tracking station at NASA's Goldstone facility in California where they will be used to calibrate tropospheric path delay fluctuations during an upcoming gravity wave search experiment (GWE) involving the Cassini spacecraft. Observing frequencies of the radiometers are 22.2 GHz, 23.8 GHz, and 31.4GHz, and the antenna beamwidth is 1 degree. The instruments are room temperature Dicke radiometers with additive noise injection for gain calibration. Design highlights include: (1) a practical temperature control system capable of stabilizing the entire receiver to a few millikelvin from day to night; (2) redundant noise diode injection circuits with 30 parts per million RF power stability; and (3) a voice coil actuated waveguide vane attenuator which is used as a high performance Dicke switch. Performance of the radiometers is evaluated from inter-comparisons of the two radiometers and from continuous tip-curve calibrations spanning nearly one year. Structure function analysis of the inter-comparison data indicates that the brightness temperature stability of these radiometers is better than 0.01 Kelvin on 1,000 to 10,000 second time scales. Analysis of tip-curve calibrations indicate RMS errors of approximately 0.05 K on 30-day time scales, and 0.15K on one year time scales.